

WHAT IS CLAIMED AS NEW AND IS DESIRED TO BE SECURED BY LETTERS
PATENT OF THE UNITED STATES IS:

1. An electrochemical device, comprising:

5 at least one substrate (1,7), at least one
electroconductive layer (2,6) at least one electrochemically
active layer (3,5) capable of reversibly injecting ions, and
an electrolyte (4), wherein the electrolyte (4) is a layer or
a multilayer stack comprising at least one layer (4b) made of
10 an ionically conductive material capable of reversibly
injecting said ions but whose overall degree of oxidation is
maintained essentially constant.

2. The electrochemical device according to Claim 1,
wherein said injected ions are H^+ , Li^+ , Na^+ , Ag^+ or K^+ .

15 3. The electrochemical device according to Claim 1,
wherein the overall degree of oxidation of the layer (4b) of
the electrolyte (4) is maintained essentially constant by
electrically insulating the said layer (4b) from at least one
of the electron sources of the device by interposing at least
20 one layer (4a, 4d) of an electronically insulating material.

4. The electrochemical device according to Claim 3,
wherein the layer(s) (4a,4d) made of electronically insulating
material is ionically conductive/ion-permeable.

5. The electrochemical device according to Claim 4,
25 wherein the layer(s) (4a,4d) made of electronically insulating
material forms part of the multilayer electrolyte (4) in
direct contact with at least one of the faces of the layer
(4b) having an overall degree of oxidation maintained
essentially constant.

30 6. The electrochemical device according to Claim 1,

wherein the overall degree of oxidation of the layer (4b) of the electrolyte (4) is maintained essentially constant by keeping the potential of said layer (4b) at values outside the range of potentials causing a variation in the degree of ion injection of the material of which it is composed.

7. The electrochemical device according to Claim 1, which comprises:

in succession, an electroconductive layer (2), an electrochemically active layer (3) capable of reversibly injecting cations, the electrolyte (4) comprising layer (4b) made of ionically conductive material capable of reversibly injecting the cations but whose overall degree of oxidation is maintained essentially constant, and optionally at least one electronically insulating layer (4a,4c), a second electrochemically active layer (5) capable of reversibly injecting cations, and an electroconductive layer (6).

8. The electrochemical device according to Claim 7, wherein said layer (3) is a cathodic electrochromic material and said layer (5) is of an anodic electrochromic material.

9. The electrochemical device according to Claim 1, wherein the material of layer (4b), which is capable of reversibly injecting the ions but whose degree of oxidation is maintained essentially constant, is a material exhibiting an electrochromic property.

10. The electrochemical device according to Claim 7, wherein the material exhibiting an electrochromic property of the layer (4b) is maintained in the decolored state or in an intermediate state of coloration.

11. The electrochemical device according to Claim 1,
which operates by reversible injection of protons from the
electrochemically active layer or layers (3,5) and in that the
material of the layer (4b) of the electrolyte (4), which is
5 capable of reversibly injecting protons, but whose degree of
oxidation is maintained essentially constant, is based on a
metal oxide or a mixture of metal oxides, optionally hydrated,
and selected especially from the group consisting of tungsten
oxide, optionally hydrated, $\text{WO}_3 \cdot n\text{H}_2\text{O}$, niobium oxide, optionally
10 hydrated, $\text{Nb}_2\text{O}_5 \cdot n\text{H}_2\text{O}$, nickel oxide, optionally hydrated,
 $\text{NiO}_x \cdot \text{H}_y \cdot n\text{H}_2\text{O}$, tin oxide, optionally hydrated, $\text{SnO}_2 \cdot n\text{H}_2\text{O}$, bismuth
oxide, optionally hydrated, $\text{Bi}_2\text{O}_3 \cdot n\text{H}_2\text{O}$, titanium oxide,
optionally hydrated, $\text{TiO}_2 \cdot n\text{H}_2\text{O}$, vanadium oxide, optionally
hydrated $\text{V}_2\text{O}_5 \cdot n\text{H}_2\text{O}$, molybdenum oxide, optionally hydrated,
15 $\text{MoO}_3 \cdot n\text{H}_2\text{O}$, where $n \geq 0$ and optionally comprising an additive
metal, which can be hydrated, of titanium, tantalum, rhenium,
or of an alkali metal.

12. The electrochemical device according to Claim 1,
which operates by reversible injection of lithium ions Li^+ from
20 the electrochemically active layer or layers (3,5), the
material of said layer (4b) of the electrolyte (4), which is
capable of reversibly injecting lithium ions Li^+ but whose
degree of oxidation is maintained essentially constant, being
based on a metal oxide or a mixture of metal oxides, which
25 optionally are lithiated, selected from the group consisting
of nickel oxide NiO_x , lithiated nickel oxide Li_yNiO_x , a mixture
of titanium and cerium oxides CeTiO_x , tungsten oxide WO_3 ,
niobium oxide Nb_2O_5 , vanadium oxide V_2O_5 and lithiated vanadium

oxide $\text{Li}_x\text{V}_2\text{O}_5$.

13. The electrochemical device according to Claim 3, wherein the layer or layers (4a,4d) of electronically insulating material includes at least one oxide of a metal of column VB of the Periodic Table and at least one metal oxide selected from the group consisting of antimony oxide Sb_2O_5 , zirconium oxide ZrO_2 , titanium oxide TiO_2 , silicon oxide SiO_2 , chromium oxide CrO_3 , these oxides being optionally hydrated and optionally comprising a hydratable metal additive of W, Re or an alkali metal.

14. The electrochemical device of Claim 13, wherein said metal oxide is a mixed Ta-Ti oxide, GeO_3 or $\text{ZnO}(\text{H}_3\text{PO}_4)_2 \cdot \text{nH}_2\text{O}$.

15. The electrochemical device according to Claim 3, wherein the layer(s) (4a,4c) of electronically insulating material is formed of CeF_3 , hexa-uranylphosphate HUP, MgF_2 , CaF_2 , SiO_x , LiF , Na_3AlF_6 , or based on Li_3N , LiTaO_3 , LiAlF_4 , Li_3PO_4 , LiPO_2 , LiN , LiNbO_3 , MgF_2POLi or Li_2WO_4 , said device operating by reversible injection of lithium ions from the electrochemically active layer or layers (3,5).

16. The electrochemical device according to Claim 1, wherein the materials which form the layer (4b) are capable of reversibly injecting the ions but whose degree of oxidation is maintained essentially constant and/or the materials forming the layer(s) (4a,4d) made of electronically insulating material are nitrided and/or phosphatized.

17. The electrochemical device according to Claim 3, wherein the layer(s) (4a,4d) of electronically insulating oxide material is a material whose electrical insulation

properties are obtained by blocking its ability to inject ions by controlling its potential.

18. The electrochemical device according to Claim 1, wherein the multilayer electrolyte (4) comprises a layer made of an ionically conductive material (4c) in the form of an aqueous liquid or of an anhydrous liquid or based on polymer(s) or on a gel(s).

19. The electrochemical device according to Claim 1, wherein the electrochemically active layer(s) (3,5) comprises a layer (5) of cathodic electrochromic material such as selected from the group consisting of tungsten oxide WO_3 , molybdenum oxide MoO_3 , vanadium oxide V_2O_5 , niobium oxide Nb_2O_5 , titanium oxide TiO_2 , a cermet material of the WO_3/Au or WO_3/Ag type, a mixture of tungsten and rhenium oxides WO_3/ReO_3 , and phosphotungstic, metallophthalocyanines or metallodibenzophthalocyanines of transition metals or of rare earths, optionally nitrided, especially in the case in which the device operates by reversible injection of lithium ions Li^+ or protons, and the same materials optionally hydrated in the case in which the device operates especially by reversible injection of protons H^+ .

20. The electrochemical device according to Claim 1, wherein the electrochemically active layer(s) comprises a layer (3) of anodic electrochromic material in the form $M_xA_yU_z$, where M is a transition metal, A is the ion used for the reversible injection, and U is a chalcogenide, which is optionally nitrided.

21. The electrochemical device according to Claim 20,

wherein said chalcogenide is S, O or Se.

22. The electrochemical device according to Claim 1, wherein the electrochemically active layer(s) comprises a layer (3) of anodic electrochromic material which, in the case of reversible injection of protons, is selected from the group consisting of LiNiO_x , IrO_xH_y , $\text{IrO}_x\text{H}_y\text{N}_z$, NiO_x , NiO_xH_y , $\text{NiO}_x\text{H}_y\text{N}_z$, RhO_x , CoO_x , CrO_x , MnO_x , and a hydride of a rare earth, of a lanthanide or of transition metals and, in the case of reversible injection of lithium ions Li^+ , selected from the group consisting of LiNiO_x , LiMn_2O_4 , IrO_x , Li_xIrO_y , NiO_x , CeO_x , TiO_x , $\text{CeO}_x\text{-TiO}_x$, RhO_x , CoO_x , CrO_x , MnO_x , VO_x , Li_x , CoO_y , LiCrO_y , Li_xVO_y , ReO_x , RhO_x , PtO_x , FeO_x , OsO_y , CuO_x , PrO_x , these compounds being optionally lithiated and/or nitrided, and, in the case of injection of protons or of Li^+ or of hexacyanometalates, of formula $\text{M}[\text{M}'(\text{CN})_6]$, with M and M' being transition metals and/or rare earths.

23. The electrochemical device according to Claim 1, wherein at least one of the electroconductive layer(s) (2,6) comprises at least one doped metal oxidized selected from the group consisting of ITO or $\text{SnO}_2\text{:F}$, or a metal or a metal alloy selected from the group consisting of gold, silver, aluminum or Ni-Cr alloy or is the superposition of several layers of these materials.

24. The electrochemical device according to Claim 1, wherein the multilayer electrolyte (4) and all of the layers of the said device contain only layers of solid material.

25. An electrochromic glazing comprising:
the electrochemical device of Claim 1.

26. The electrochromic glazing according to Claim 22, which has a variable light transmission coefficient with the essentially transparent substrate or both substrates (1,7) made of glass or of plastic.

5 27. The electrochromic glazing according to Claim 22, which has a mirror function by combining the electrochemical device with a reflecting element, or by choosing a reflecting opaque substrate, or by choosing one of the electroconductive metal layers (2,6) sufficiently thick to be reflecting.

10 28. The electrochromic glazing according to Claim 22, which comprises said electrochemical device comprising one or two transparent or barely absorbent substrates (1,7) mounted as double glazing or as a parietodynamic window using another transparent substrate (9).

15 29. The electrochromic glazing according to Claim 22, comprising:

a stack of glass (7)/electroconductive layer/ NiO_xH_y or IrO_xH_y (3)/ $\text{Ta}_2\text{O}_5 \cdot n\text{H}_2\text{O}$ (4c)/ $\text{WO}_3 \cdot n\text{H}_2\text{O}$ (4b)/ $\text{POE} \cdot \text{H}_3\text{PO}_4$ (4a)/ WO_3 (5)/electroconductive layer/glass (1).

20 30. The electrochromic glazing according to Claim 22, comprising the stack of:

substrate (1)/electroconductive layer(s)/ WO_3 (3)/[$\text{Ta}_2\text{O}_5 \cdot n\text{H}_2\text{O}$ or $\text{Sb}_2\text{O}_5 \cdot n\text{H}_2\text{O}$ (4a)/ $\text{WO}_3 \cdot n\text{H}_2\text{O}$ (4b)/ $\text{Sb}_2\text{O}_5 \cdot n\text{H}_2\text{O}$ or $\text{Ta}_2\text{O}_5 \cdot n\text{H}_2\text{O}$ (4c), optional]/ NiO_xH_y or H_xIrO_y or $\text{NiIr}_2\text{O}_x\text{H}_y$ or $\text{Ir}_x\text{Sn}_2\text{O}_x\text{H}_y$ (5)/electroconductive layer(s).

25 31. The electrochromic glazing according to Claim 1, comprising the stack of:

substrate/electroconductive

layer(s)/WO₃/[NiO_xH_y·nH₂O/WO₃·nH₂O]_n/NiO_xH_y or IrO_xH_y or NiIr₂O_xH_y or IrSn₂O_xH_y/electroconductive layer(s), where $n \geq 1$.

32. A display element of the information screen or advertising panel type, comprising:

5 a plurality of juxtaposed electrochemical devices according to Claim 1.

33. A energy storage element, comprising the electrochemical device according to Claim 1.

34. A gas sensor comprising:

10 the electrochemical device according to Claim 1.

35. A process for manufacturing the electrochemical device according to Claim 1, comprising:

15 depositing at least some of the layers of the device by a sputtering and/or evaporation vacuum technique and/or sol-gel pyrolysis techniques.

36. A method of preparing a glazing for buildings, windows for motor cars, windows for industrial or public-transport vehicles, windows for trains, windows for aircraft, rear-view mirrors and other mirrors, as optical elements such as camera objectives, as the front face or element to be placed on the front face of display screens of computers or televisions as display elements, comprising:

performing the fabrication from the glazing of Claim 22.

37. A method of preparing electronic and/or data processing equipment and energy storage devices which is intrinsic to them, whether or not autonomous, by fabricating these items from the energy storage element according to Claim 33.

38. The method of Claim 37, wherein said energy storage device is a flat battery for watches, smart cards, self-powered labels, domestic electrical appliances, vehicle batteries, using as substrate(s) one or more flexible plastic
5 substrates.